Tracking Drinking Water Contaminants

Examples, Issues and Recommendations

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What is Water Quality Data?

- Water quality data is routinely collected water sampling information to assist regulatory agencies in monitoring and enforcing water quality standards
  - In CA ➔ Systems (~2K), Stations (~10K), and Samples (~4M)

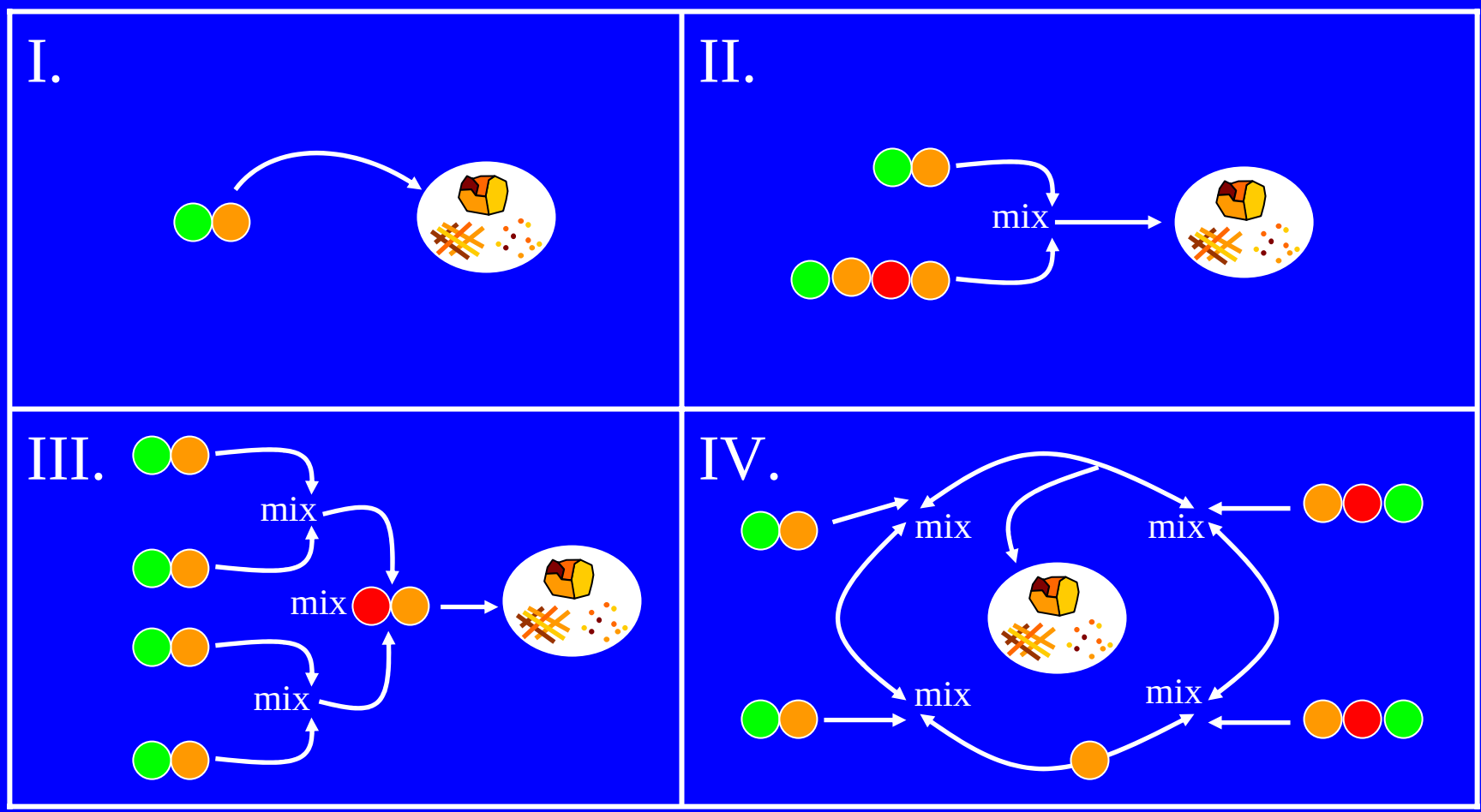
- Since water quality standards were created to keep contaminants under a maximum concentration level (MCL), information about population-level exposures is not typically reportable, nor centralized

Water Quality Data is not Exposure Data

- Proximity to a water sample does not always imply an exposure
  - Water quality data does not tell us where water flows after sampling
- Water quality often changes after it's sampled
  - Treatment and mixing
- Other issues: consumption patterns (bottle vs tap), exposure period, etc.

Water Delivery can be Complex

= source = sample = treatment = consumers



Water "Exposure" Objectives

- Systematically link subjects to relevant (spatial/temporal) water quality samples

- Adjust and aggregate samples to reflect best approximation of water quality at downstream receptor site (home/work connection), given
  - History of detections and non-detections at station
  - Treatment downstream from station
  - Dilution downstream from station
  - Other factors influencing contaminant concentrations after sampling

Outline of Previous Method

1. Linkage of subjects to systems
2. **Questionnaire mailer to systems**
3. **Compilation of surveys, QA/QC**
4. Linkage of subjects to stations
5. Linkage of subjects to samples

Red = bad for tracking

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Method Assumptions

- One water system serves a single address range
- Relevant time period surrounding event date (e.g. *n* years before diagnosis)
- After adjusting for dilution and treatment, contamination levels at sampling stations indicative of levels at tap
- Subjects are being “exposed” to waterborne pollutants via drinking, showers, etc.
- Data quality is acceptable

Linkage of Subjects to Systems

- Complete coverage of water system extents not available, so systems must verify service to address [range]
- Want to minimize number of systems contacted and number of address ranges presented to each system
- Developed weighting algorithm for each subject/system pair (see poster)

Questionnaire Mailer

- Systems solicited for:
  1. Confirmation of water service during exposure window
  2. Identification of sampling stations (in sequence) upstream of residential connection
  3. Identification of treatment types used and whether they occur before or after sampling
  4. Best estimate of percent contribution volume of sampling location to downstream address range

Survey Compilation

- Data manually entered from hardcopy or transferred from electronic spreadsheets into database

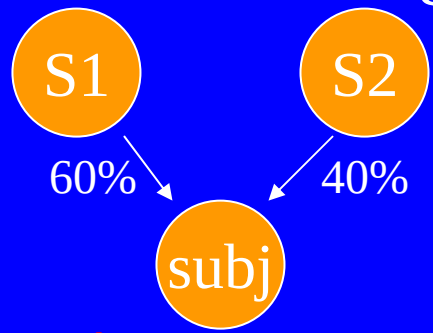
- Variables include:
  - Station code
  - Average volume contribution
  - Treatment codes
  - Flag whether treatment occurs before/after sample station
  - Time period of relevance
  - Alternate grouping identifier (recursive tree)

- Additional contact with water systems for wholesale scenarios and complex configurations

Linkage of Subjects to Stations

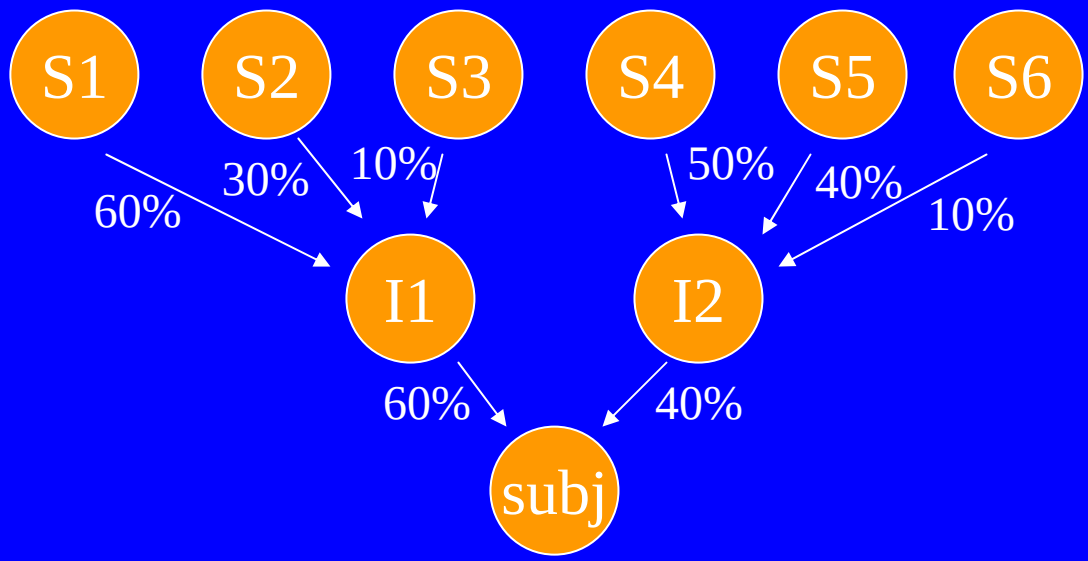
- Simple: 100% of volume at sampling stations contribute to downstream address range

- More Complex: unequal proportions of water at sampling stations contribute to downstream address range



Linkage of Subjects to Stations

- Quite Complex: unequal proportions of water at sampling stations dilute at intermediate points and contribute to downstream address range

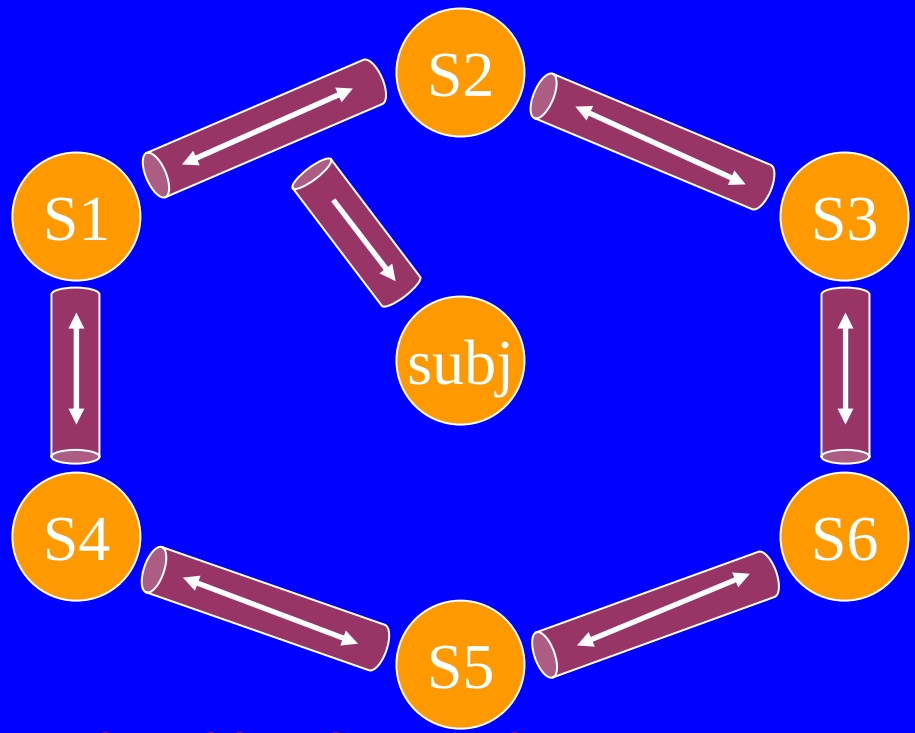


$V_c(Sn)$ = % volume contribution of Station *n* to subject

$V_c(S1)=36\%$
$V_c(S2)=18\%$
$V_c(S3)=6\%$
$V_c(S4)=20\%$
$V_c(S5)=16\%$
$V_c(S6)=4\%$

Linkage of Subjects to Stations

- Very Complex: Loop-type system having sources within distribution system; Typical of flat, groundwater systems; bi-directional and demand-dependent flow



$V_c(Sn)$ = % volume contribution of Station *n* to subject

$V_c(S1)$=?
$V_c(S2)$=?
$V_c(S3)$=?
$V_c(S4)$=?
$V_c(S5)$=?
$V_c(S6)$=?

Treatment Adjustment

- Removal rate applied to raw water samples receiving treatment downstream from sampling station
  - chemical- and treatment-specific rates obtained from literature search
  - most conservative rates used

Linkage of Subjects to Samples

- Sample must have occurred during exposure window
- Non detect samples
  1. "Zero" concentration for NDs at stations never having detection
  2. "Half" detection limit (EPA) for NDs at stations with at least one detection in sampling history
- All non-zero samples adjusted for applicable post treatment and dilution
- Exposure metric is average of all sample values at stations linked to subjects

Issues

- Close contact with water systems results in useful information for single disease distribution and single exposure window
  - New disease distribution? Do it all over again.
- Can't systematically determine the supplier of drinking water for an address
  - Our best guess was right only 35% of the time
- 10-15% of population receives non-State reportable water

Issues

- Lack of centralized information on: 1. operation of stations, 2. Weighted contribution of flow at stations to downstream consumers
- Water transfers and water treatment information difficult/impossible to track temporally and along sequence of stations leading to receptors
- Water treatment info not collected in terms of non/target removal species or removal rates

Recommendations

- Establish tracking system(s) for individual level drinking water exposures!!!
  - State-specific? Nationwide?

- Pursue exploratory demonstration projects
  1. Survey water systems to identify requirements for establishing system-to-community and station-to-community linkages
  2. Perform an exposure assessment and validation study using existing water quality data and tap-water samples

Recommendations

- Create and maintain central tracking system for water system customer information. Collect address, connection start/end date, sub-zone (pressure), temporal-dependent demand metric

- For systems with multiple sources and/or sub-zones with high spatial concentration variations, create central tracking system for linking sampling stations to sub-zones. Collect temporal-dependent volume contribution metric.

- Don't need detailed infrastructure info like pipes, locations of pumps, valves, hydrants, pipe width/length

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Recommendations

- Collect detailed water treatment information
- Collect sampling information for private sources
- It's unclear whether legislation will be needed for some or all of these recommendations
- BT event response could utilize these data and methods